

# **GOLDFIELDS WATER SUPPLY SCHEME – ONE OF WESTERN AUSTRALIA’S ENGINEERING HERITAGE TREASURES**

**Australian Engineering Week Tour 2011**

**To Mundaring Weir and the No. 1 Pump Station Museum (part of the Golden Pipeline Project)**

**Presented by Engineering Heritage WA**



Photo from the Forrester Family National Trust Collection

## Introduction

In January 1998, the Water Corporation of WA and the National Trust of Australia (WA) reached an agreement whereby all heritage aspects of the former Goldfields Water Supply Scheme would be managed by the National Trust under the name of the **Golden Pipeline Project**. This agreement included the transfer of a number of decommissioned assets of the original scheme to the National Trust for conservation and interpretation. The Corporation provided seed funding of \$ 1.3 million to enable the National Trust to commence work on the Golden Pipeline Project and subsequent grants from State and Federal Governments enabled the Trust to carry out

- Conservation work on the original steam powered pump stations
- The redevelopment of No.1 Pump Station as a museum and interpretive centre detailing the history of the scheme.
- Creation of walking trails in the vicinity of Mundaring Weir and a multi-use trail between Mundaring Weir and Northam.
- A heritage drive trail from Mundaring Weir to Kalgoorlie with accompanying guide book.
- The development of a comprehensive education program

In addition to the above objectives, in 2002 the Corporation commissioned Dr Richard Hartley, an engineering historian, to research and write a history of the Goldfields Water Supply Scheme from 1895 up to 2003. Dr Hartley was assisted by an editorial committee which included Mr Harold Hunt and Mr Ken Kelsall, both formerly Chief Engineers of the Public Works Department of WA.

Five years later the history, ***River of Steel***, was published by Access Press for the Water Corporation and the National Trust.

The Water Corporation continues to operate and maintain Mundaring Weir and two electric powered pump stations (A&B) have replaced the original steam powered pumps station. In the near future A&B stations will be replaced by a new electric powered station.

### **Reasons for Writing *River of Steel***

The construction of the Goldfields Water Supply Scheme, originally known as the Coolgardie Water Supply Scheme, or '**O'Connor's pipeline**', as it is often called, is widely recognised in Australia as having been an engineering achievement which attracted world-wide attention and which extended the boundaries of hydraulic engineering. Even the scale of the scheme is an engineering wonder and the pipeline, which was the first of any size built of steel, is still the longest steel freshwater pipeline in the world. It has been operating for over a century without a single break of service of more than two or three days.

***River of Steel*** was written to

- tell the story for non-specialist readers of the impounding weir, the pump stations, the pipeline and its network of services over a period exceeding one hundred years, how they were designed, built, managed, operated, maintained, refurbished and expanded. The efforts to maintain it in service – from the routine slog to the heroic – and to rebuild the whole line above ground, were as much a wonder as the scheme's original construction.
- Tell the stories of the people who did these things, how they lived and how they did their work.

The construction, maintenance and operation of the Scheme involved a number of inventions and innovative procedures which the book highlights and explains in terms which people with limited scientific literacy can understand. These include:

- Mephan Ferguson's locking bar pipe which bridged the technological gap between riveted pipes and welded pipes. In 1900 when gas welding was still in the development stage and when pipes with riveted longitudinal joints subject to thermal movements could be expected to have high leakage rates, the locking bar pipe made a 550 km pipeline a practical proposition.
- Couston's mechanical caulking machine overcame the difficulties of hand caulking the leaded joints between pipes, ensured a uniform standard of caulking and speeded up the pipe laying operations.
- The pumping stations were designed and located such that all 20 steam pumps were identical (except there were two plunger sizes).
- To reduce pipeline corrosion caused by aeration, in 1917, a vacuum water deaerator was installed at Mundaring Weir capable of removing 90% of dissolved oxygen from 6 million gallons of water per day. The machine was the first of its kind in Australia.

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- To overcome the increasing water losses from the leaded joints between pipes, in 1932 Norman Fernie, the pipeline district engineer at Northam, devised a new method of relaying pipes above ground as a fully welded pipeline. The forces due to thermal movements and directional changes were resisted by reinforced concrete anchor blocks. After extensive trials the decision was taken to commence relaying the whole pipeline, a task which took ten years.
- Between 1946 and 1951 Mundaring Weir was raised by ten metres by placing additional mass concrete on the downstream side. To ensure that the new concrete and the original concrete bonded together to act monolithically an innovative method was devised of forming slots between the new and old concrete and later filling the slots with grouted aggregate.
- In the 1970s the first moves towards the remote control of pumping operations began. This eventually led to de-manning of main line pumping stations and the development in the 1990s of fully automatic operation of the main conduit.

In researching the history of the Goldfields Water Supply Scheme the author and his assistants had access to over 2000 Public Works Department files, annual reports and other official documents. He was able to interview 26 people who had worked, often for long periods, for the GWSS in a range of occupations from Chief Engineer to workers in pipeline maintenance gangs. His engineering training allowed him to clarify a number of issues the background to which lay historians, who had published previous books about the controversial beginning to the Scheme, could not have been expected to have understood. Some of these issues are referred to below:

#### **C Y O'Connor's Suicide**

The tragic death of the Chief Engineer of the Public Works Department, Charles Yelverton O'Connor, ten months before the Coolgardie Water Supply Scheme was completed, is well known. One urban myth is that O'Connor took his own life because when the pumps were started water did not flow. What is not well known is the real cause of his untimely death. From the scheme's conception many parliamentarians strongly opposed the scheme for a number of reasons, such as the high cost and predicted impracticability. While Sir John Forrest was Premier he was able to shield O'Connor in parliament from these criticisms and the many false accusations of mismanagement made under parliamentary privilege. However when he resigned in 1901 to become a Western Australian representative in the Federal Parliament his successor did not have the same confidence and trust in O'Connor and he agreed to a Royal

Commission to be set up in early 1902 to enquire into the accusations of mismanagement and further false allegations, such as the one published by the Sunday Times that O'Connor was corrupt. O'Connor was quite content to ignore accusations of his technical competence because he knew his engineering judgment was sound but was very hurt by the suggestions that he was dishonest. Coupled with his knowledge that several of the Royal Commissioners were opponents of the scheme (and thus he was unlikely to get a fair hearing) and his current poor health as a result of overwork, he took his own life on March 10, 1902, five days after the Royal Commission began taking evidence and three weeks before No.1 pump station began operating.

### **Thomas Cowley Hodgson: A Scapegoat for the Royal Commission?**

Thomas Hodgson (1858-1939) was a very capable hydraulics engineer responsible for the design of many important aspects of the Scheme and, as O'Connor's deputy, was Engineer-in-Charge of the scheme. After O'Connor's death the Royal Commission's proceedings were deliberately staged to incriminate Hodgson for the events leading up to O'Connor's suicide. Hodgson some years earlier had purchased land near Cunderdin with the objective of becoming a farmer when he retired from his engineering profession. During the design phase of the project No.3 pump station was located at Cunderdin and the Royal Commissioners concluded that Hodgson was responsible for locating the pump station at Cunderdin thereby increasing the value of his land. In fact the pump station was located at Cunderdin for technical reasons, a fact verified by an independent Commission of English Engineers that O'Connor had engaged to provide technical advice to the PWD design team. The Cunderdin issue, and a somewhat unconventional but justifiable decision by O'Connor and Hodgson to negotiate with James Couston to design, manufacture and commission a mechanical caulking machine to speed up the pipelaying, led the Royal Commission to conclude that "improper acts by Hodgson finally unbalanced O'Connor's already overstrained mind, leading to his suicide." Hodgson was suspended from duty on 30 May, 1902, and resigned from the PWD in August 1902. His brilliant career as a hydraulics engineer was over.

## **Other Engineers Who Contributed to the Success of the Goldfields Water Supply Scheme:**

### **William Coates Reynoldson**

William Reynoldson (1870-1942) was Acting Chief Engineer-in-Charge of the Coolgardie Water Supply Scheme after Hodgson's resignation and was responsible for the successful completion of its construction. From 1903 he was Chief Engineer of the Goldfields Water Supply Administration during its important first decade. He was responsible for establishing an organisation for the long term maintenance of the pipeline. During his tenure the first serious leakage problems became evident and he formed a committee of people with metallurgical, chemical and corrosion expertise to study the problem and seek international advice when necessary.

### **Percy Vincent O'Brien**

Percy O'Brien (1865-1951) for over thirty years was responsible for all water supplies on all Western Australian goldfields including the maintenance and operation of the Goldfields Water Supply. In 1912 the Government established a new department which was to be responsible for all water orientated services outside the Metropolitan area and O'Brien became Engineer Goldfields Area, whose responsibilities included the operation of the Goldfields Water Supply. The systematic monitoring of flows and leakage losses from the main conduit begun by Reynoldson was continued by O'Brien and his assistant Walter K Weller, who had joined the PWD as a cadet in 1898, and John Parr, GWS District Engineer at Northam. Initially lime dosage was tried at Mundaring Weir – the large below ground concrete tank west of the No. 1 pump station is a legacy of that initiative. That was not successful so Weller, using a consultant's laboratory scale model, designed and supervised the construction of a mechanical deaeration plant to operate on a full scale flow of 6 million gallons per day which commenced successful operation in 1925.

Meanwhile O'Brien and Parr prepared a paper for the Institution of Civil Engineers of the UK setting out the work done in attempting to reduce corrosion from 1903 to 1915 as a full case history. When the paper was read in London in 1917 it caused a minor sensation and the discussion at the meeting and written responses were more extensive than any other paper given to the Institution in the previous twenty years. O'Brien and Parr, to their surprise and delight, were both awarded the ICE's **Stephenson Prize** and the **Telford Premium** prize for their paper, a rare honour never previously bestowed on Australian residents.

## **Norman Fernie**

Norman Fernie (1898-1977) who followed John Parr as District Engineer at Northam, was the engineer who solved the problem of leaded joint corrosion by devising a method of relaying the Goldfields Water Supply Pipeline above ground as a continuously welded pipeline. He was one of the first engineering graduates from the University of WA in 1920. On his own initiative he carried out experimental trials in which lengths of pipe were laid above ground with fully welded joints and the substantial forces generated by large daily temperature changes restrained by reinforced concrete anchors. In 1933 a decision was taken to reconstruct the whole pipeline as a continuously welded above-ground main. To excavate 565 km of 30 inch diameter pipes, clean them, line them with cement mortar, weld them together and anchor them against thermal movements was a mammoth task. The work was carried out during the depression years by an army of the unemployed who were engaged for varying periods during any one week according to the size of their families.

In 1934 Norman Fernie, and his colleague R. J. Keating, were both awarded the **R.W.Chapman Medal** for advances in structural engineering by the Institution of Engineers Australia, following their paper on the Continuously Welding of Exposed Mains on the Goldfields Water Supply.

Norman Fernie had a distinguished career in the Public Works Department. In 1939 he joined the Department of Industrial Development and Employment and two years later he was appointed the first Director of Industrial Development. In this capacity he was largely responsible for the establishment of the Wundowie Charcoal Ironworks (1948) and the Chamberlain Tractor factory (1949). In 1950 he became Managing Director of Griffin Coal Mining Co. Ltd.

## **Honours and Awards**

In addition to the awards given to O'Brien and Parr, and to Fernie and Keating, the Institution of Engineers Australia, in September 1987, designated the Coolgardie Water Supply Scheme, an Australian National Engineering Landmark.

As a result of the research, writing and publication of ***River of Steel*** in 2002 -2007 the Goldfields Water Supply Scheme attracted the attention of the History and Heritage Committee of the American Society of Civil Engineers (ASCE). The ASCE invited Engineering Heritage Australia to nominate the Goldfields Water Supply for its prestigious International Historic Civil Engineering Landmark award. A nomination prepared by the WA Division of Engineers Australia in 2008 was

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successful and commemoration ceremonies to unveil IHCEL plaques presented by the ASCE were held in October 2009 at Mundaring Weir and Mt Charlotte, Kalgoorlie. The Sydney Harbour Bridge and the Snowy Mountains Hydro-Electric Scheme are the only other Australian sites similarly recognised.

In November 2009 Engineering Heritage Australia presented the **Colin Crisp Award for Excellence in Engineering Heritage** to the Water Corporation of WA and the National Trust of Australia WA for their nomination of ***River of Steel*** in the category 'recording and documentation of engineering heritage'. More recently Richard Hartley has been awarded the **Telford Premium** prize by the Institution of Civil Engineers of the UK for his paper presented to the ICE entitled ***Lessons from Western Australia's Goldfields Water Supply Scheme***.

Finally in June this year the Minister for Sustainability and Communities, The Hon Tony Burke MP advised the National Trust of Australia WA that the Goldfields Water Supply Scheme had been added to the **National Heritage List**. It shares this honour with other WA sites such as the Batavia Shipwreck and the Fremantle Prison.

Prepared by Don Young and Richard Hartley



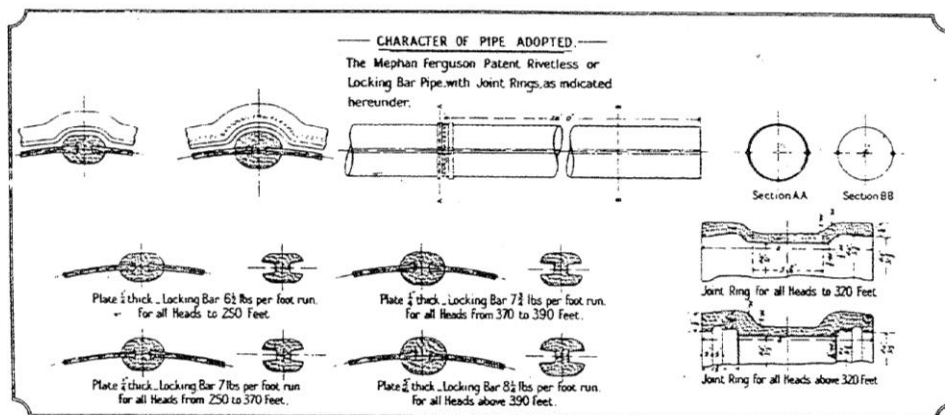
Bust of CY O'Connor at Mundaring Weir (D. Young)



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Mundaring Weir under construction. This image shows a train delivering cement and ramp for concrete trolleys (Battye Library)



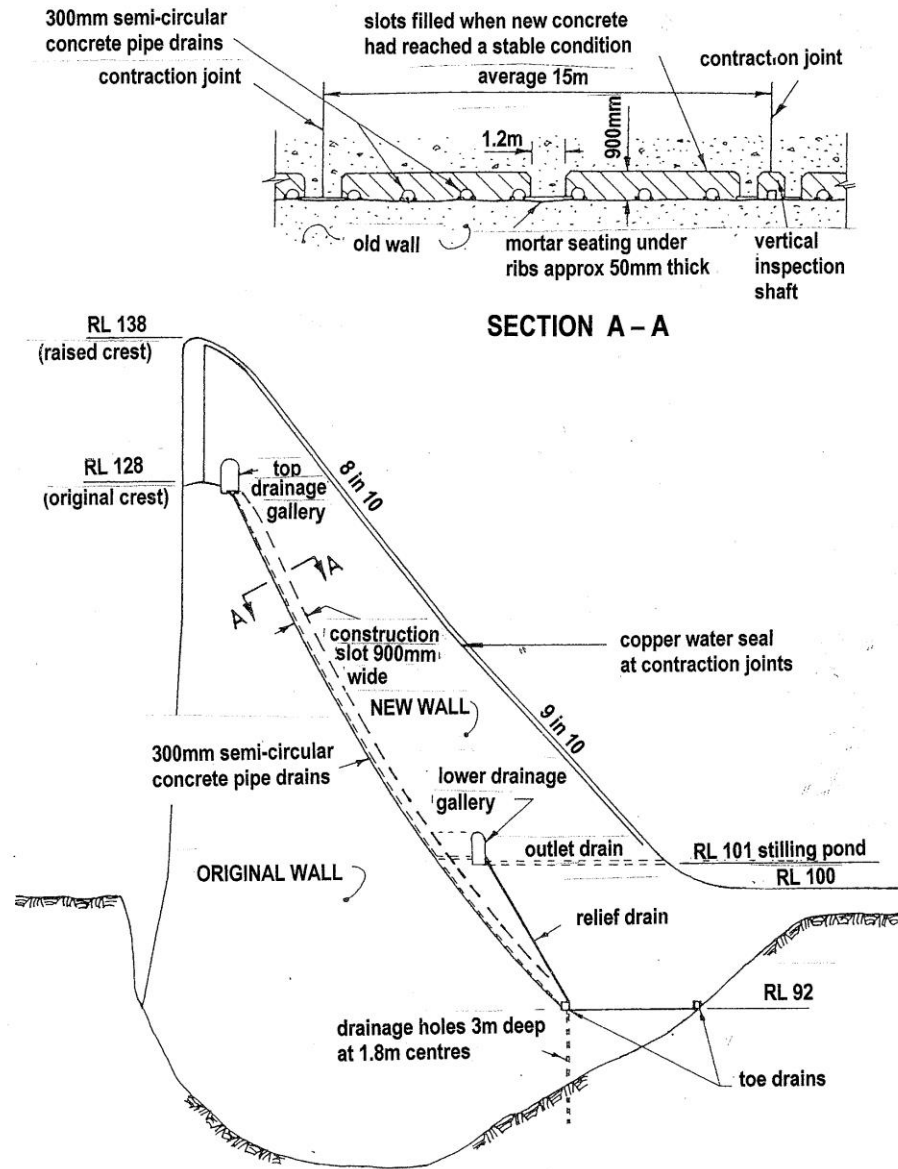
Locking bar joint detail

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No. 1 Pump Station from top of the Weir (L. Margetts)

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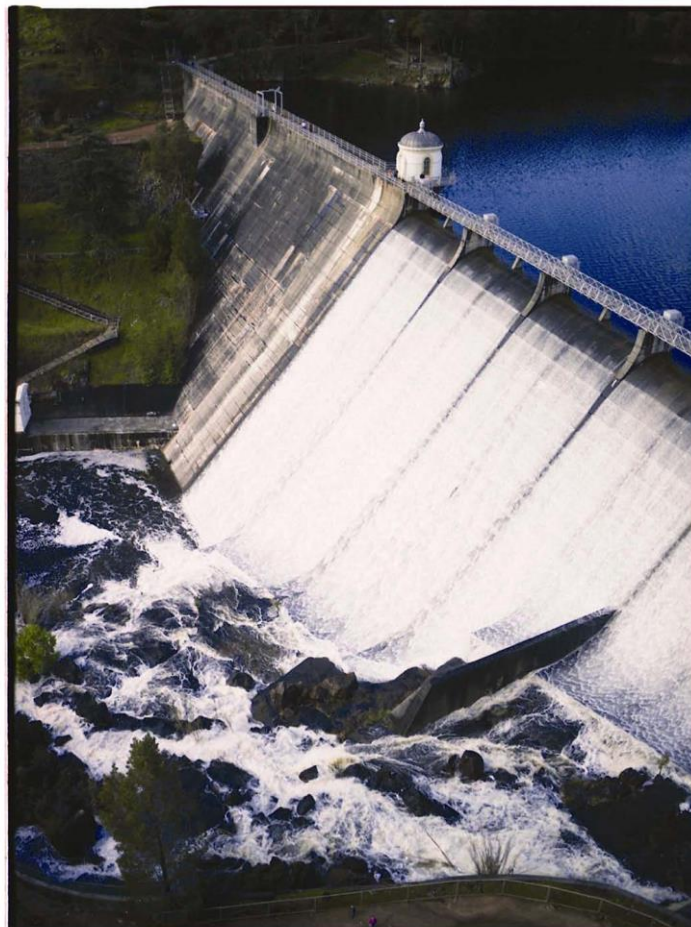


Raising of Mundaring Weir, typical cross-section of wall (IEAust)

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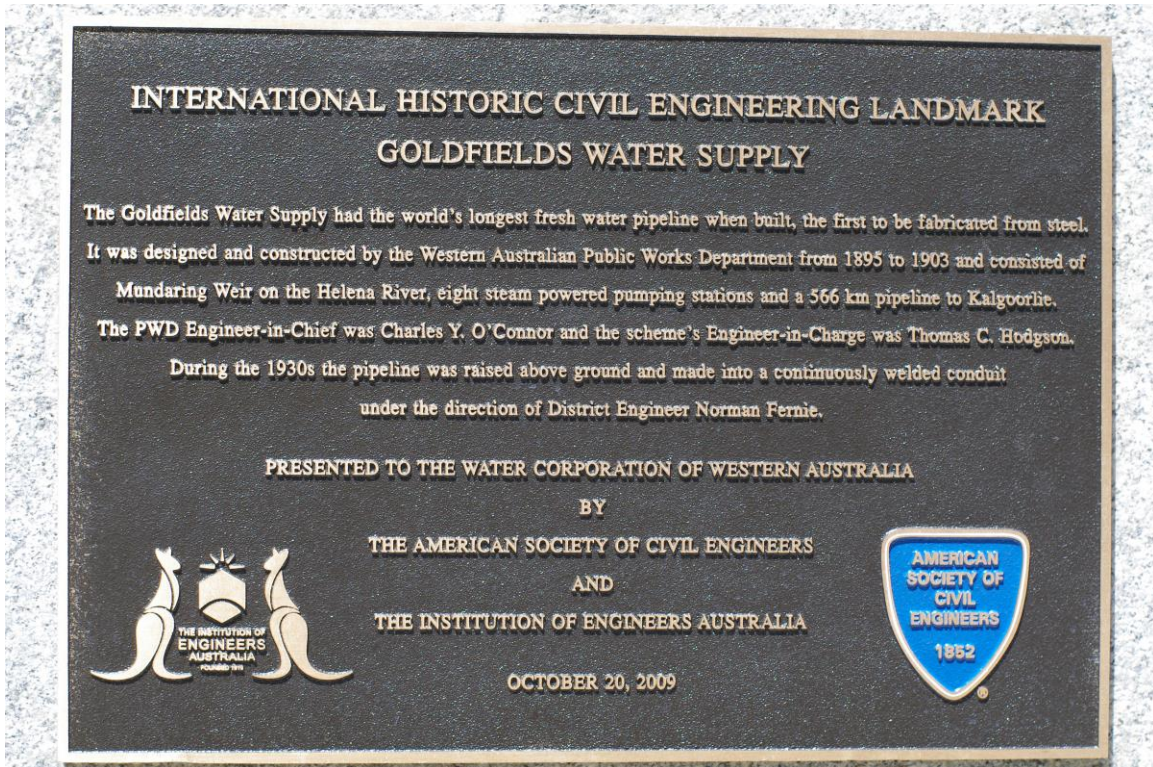


A section of above ground continuously welded pipeline (National Trust)

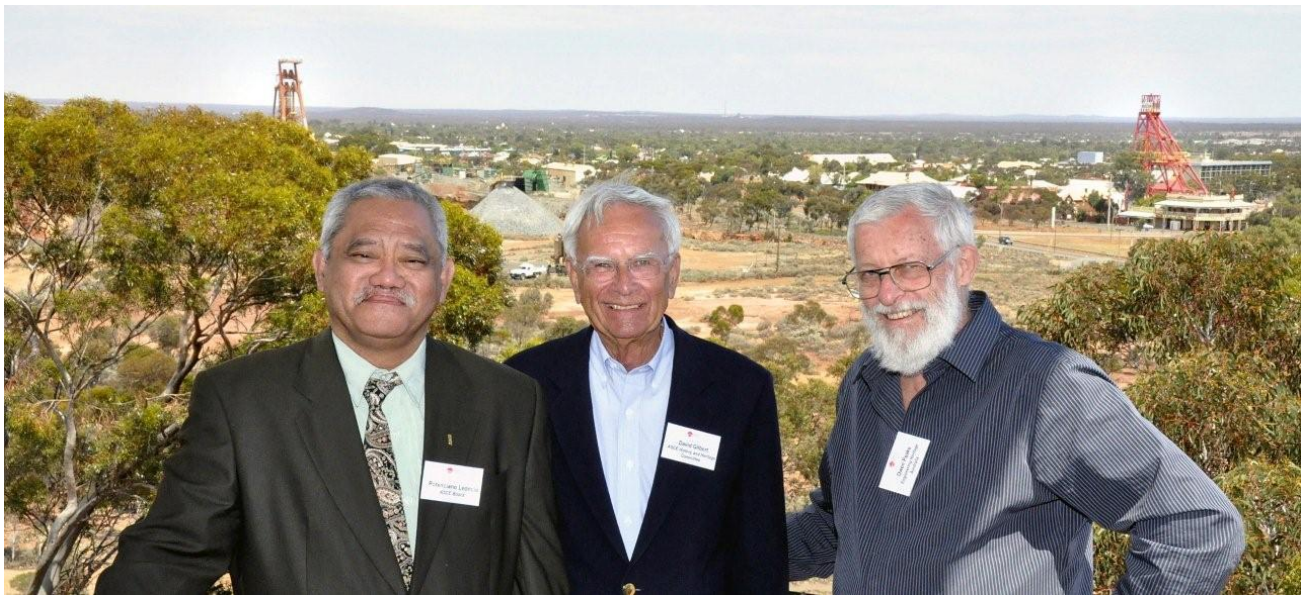


Mundaring Weir during the most recent overflow in 1996 (Water Corporation)





ASCE Plaque



P Leoncio and D Gilbert (ASCE); O Peake (EHA), at Mt Charlotte

### **Acknowledgments and References**

1. River of Steel, a History of the Goldfields and Agricultural Water Supply, by Dr R G Hartley, 2007
2. Building a State, The Story of the Public Works Department of Western Australia, 1826 – 1985, by J H S Le Page, 1986
3. C Y O'Connor, His Life and Legacy, by A G Evans, 2001
4. Nomination of the Goldfields Water Supply Western Australia for an ASCE International Historic Civil Engineering Landmark Award, by Engineers Australia WA Division, 2008
5. Nomination of River of Steel for a Colin Crisp Award for Excellence in Engineering Heritage, by the Water Corporation of WA and the National Trust of Australia, WA, 2009

### **Engineering Heritage WA Website**

For further information about Engineering Heritage WA's heritage recognition program visit:

<https://www.engineersaustralia.org.au/western-australia-division/western-australia-branch-engineering-heritage-panel>

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